# Pseudo-CT Image Generation from Magnetic Resonance Imaging (MRI) Using Generative Adversarial Networks (GANs) for Radiation Therapy Planning

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## Introduction

 Radiation therapy plans require CT imaging to generate electron density maps for dose prescription and MRI imaging to aid in tumor delineation. This dual imaging approach significantly increases the cost, time investment, and congestion within veterinary imaging departments. The objective of this study is to observe if GANs can develop accurate pseudo-CT images from MRI images for radiation therapy planning.

## Methods

 This study acquired radiation therapy head standard CT images and T2 TRAN + C 3D FSPGR head MRI images for 45 non-brachycephalic canines with brain tumors who received radiation therapy at the Ontario Veterinary College. Image preprocessing for this study involved down sampling the CT images, rigidly registering the MRI and CT images, and normalizing the pixel data between 0 and 1. A conditional GAN (CGAN) with a U-Net encoder and PatchGAN classifier for the discriminator was used to generate the pseudo-CT images. Quantitative performance metrics for this study include mean absolute error (MAE), peak signal to noise ratio (PSNR), normalized mutual information (NMI), and dice scores for the entire cranial cavity and bone. Qualitative assessment for the pseudo-CT images involved having veterinary radiologist rank the quality of the pseudo-CT images in comparison to the actual CT images on a scale of 1 (poor quality) to 5 (exceptional quality).

## Results

 The average MAE was 142.92 ± 6.29 HU, the PSNR was 43.03 ± 6.29 dB, and the NMI was 0.64. The dice similarity score for the entire cranial cavity (fat, white matter, grey matter, water, and bone) was 0.718, where as the dice similarity score for just bone was 0.361. All these metrics were calculated between the actual CT images and the pseudo-CT images. For qualitative results the average score given by the veterinary radiologists was a 2 (low quality).

## Conclusion

 This model can produce relatively accurate pseudo-CT images; however, other types of GANS should be explored as this model is unable to produce detailed enough pseudo-CT images to be used for clinical diagnoses as seen from the ranking provided by the veterinary radiologists. This model demonstrates that MRI-based radiation therapy planning may be possible in veterinary medicine with further exploration.